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AUTOCLAVE-FREE PRODUCTION OF WATER GLASS

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A new autoclave-free technology has been developed for the production of water glass from impure sodium disilicate. A comparative analysis of glass produced using the proposed method and glass obtained by autoclave dissolution has been performed. It is established that the glass produced by the proposed technology is similar in properties to the product of autoclave dissolution.

Lately water glass has acquired an increasing use in various sectors of industry. This is related to the fact that apart from having good binding properties, water glass is a nontoxic and noncombustible material; its production and application is environmentally clean, and its initial materials are easily available. The extensive application of this binder is also due to its relatively low cost [1].

A new technology has been developed (RF patent No. 2194011) for the production of water glass under atmospheric pressure, including preliminary mechanical activation of alkali silicates (impure sodium disilicate) and subsequent dissolution in a vibration reactor [2, 3]. The mechanical activation of silicates is carried out in plants with an increased electric intensity. Owing to that, besides dispersing impure sodium disilicate, its structure is modified as well [4], which eventually leads to its increased solubility. Furthermore, the high rate of silicate dissolution is ensured by intense and yet low-energy-consuming mixing that takes place in dissolving silicate in the vibration reactor [5]. As a consequence, complete dissolution of sodium disilicate is attained in 35 – 45 min (depending on the silica modulus of the material) and of potassium disilicate in 20 – 25 min.

After dissolution, water glass is allowed to settle for 2 – 3 days and then is brought to the required condition by correcting its parameters (silica modulus, density, viscosity). Usually glass viscosity is corrected by mixing solutions of different viscosity in a blender. Other parameters can be specified before dissolution: the silica modulus of glass can be set by selecting impure sodium disilicate with a certain modulus; glass density can be set by a corresponding selection of the dissolution parameters (silicate : water ratio, temperature, process duration). It is rather difficult to predict (preset) the level of viscosity before the dissolution due to the complexity of the polymerization process.

This technology makes it possible to obtain different types of water glass (sodium, potassium, potassium-sodium, sodium-potassium), including high-modulus (silica modulus over 3.1). This glass is used in molding welding electrodes, in the production of lacquer and paint materials (paint, paste, primer, etc.), in impregnating wooden products in order to increase their fire resistance, and also in briquetting finely dispersed material. Practical experience has demonstrated that the use of water glass produced according to the above technology yields product of the required quality and does not cause technological complication.

A comparative analysis of sodium water glass produced by the above technology and the product of autoclave dissolution was performed. Both glass samples were obtained from the same raw material and had similar silica modulus (Table 1), density, and viscosity. It was found that a distinctive feature of the glass produced according to the autoclave-free technology is its dark gray hue caused by the presence of various iron compounds acquired by the silicate in the course of mechanical activation and dissolution. The iron impurity affects the exterior appearance but has no perceptible effect on the main technological properties of glass. Water glass can be clarified by centrifuging the solution, its filtration using a press-filter in the presence of a sorbent, or by the usual settling, whose duration depends on the density and viscosity of the product to be clarified.

Furthermore, the time of setting of water glass reacting with ferrochromium slag was compared using the following scheme. The slag was mixed with water glass, then the mixture was placed in a mold, and the time of its setting was determined using the Vika instrument according to the testing methods for binding material (GOST 125–70, GOST

TABLE 1

Production method	Mass content, %, in water glass			Silica modulus
	SiO_2	Na_2O	Fe_2O_3	
Autoclave	29.45	10.42	0.11	2.92
Autoclave-free	28.96	10.29	0.19	2.90

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TABLE 2

Production method	Setting time, min, for ferrochromium slag mixed with water glass	
	beginning	end
Autoclave	20	35
Autoclave-free	5	18

310.1–76). It follows from the data in Table 2 that the product of autoclave-free dissolution reacts more intensely with slag, and its mixture sets faster than the mixture based on glass produced by the autoclave method.

Adhesion was evaluated using a PS-4 instrument (USSR Inventor's Certif. No. 249023). The tests demonstrated that the adhesion strength of two metal samples fixed by glass produced by the described technology is not inferior to the strength of adhesion of samples fixed by the product of autoclave dissolution.

Thus, water glass produced according to the technology described above is not inferior in its main parameter to glass produced in an autoclave.

It should be noted that this technology can be successfully implemented by a small company, where small-scale batch production lines are advisable. This technology does not require complex specialized machinery, nor special training of personnel. High-quality glass meeting all necessary requirements can be produced in a short time; moreover, its production cost compares favorably with existing analogs. Consequently, this method can be regarded as an alternative to the existing production methods.

Since 2000 this technology has been implemented at the Welding Materials Factory in the town of Berezovskii, Sverdlovsk Region. To date, this factory has produced over 200 tons of water glass of various compositions.

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